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ABSTRACT

A study investigated the extent to which instructional films by themselves can teach a body of factual information. Three comparable groups of ninth-grade students were taught a course in general science. One group saw a series of 44 films and received no other instruction. The second group saw the films and studied specially prepared short study guides. The third group was taught by teachers using a standard textbook and customary teaching techniques, other than films. Test results showed that intermethod differences were small and generally not significant. The three methods were of almost equal effectiveness, where the learning of factual information was the sole criterion. (Author/JK)

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TECHNICAL REPORT - SDC 269-7-13

RELATIVE EFFECTIVENESS OF INSTRUCTION BY: FILMS EXCLUSIVELY,
FILMS PLUS STUDY GUIDES, AND STANDARD LECTURE METHODS

(Rapid Mass Learning)

The Pennsylvania State College
Instructional Film Research Program
July 1950

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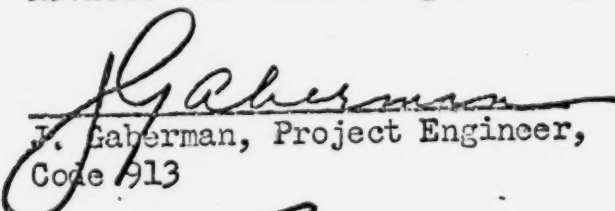
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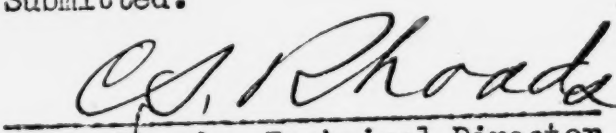
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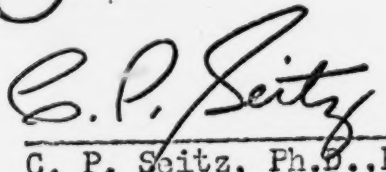
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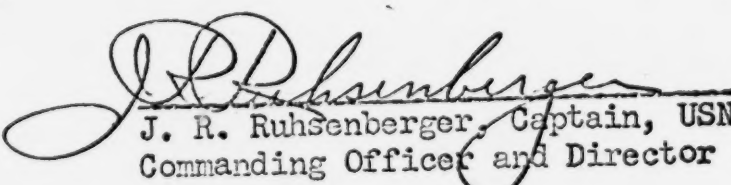
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SUMMARY

The Problem

A shortage of competent instructors and a lack of sufficient equipment for training purposes are likely to occur in the event of a national emergency. One of the objectives of the Instructional Film Research Program is to discover whether motion pictures can, if the need arises, alleviate such shortages of instructors and equipment.

This study was undertaken to determine whether and to what extent instructional films can carry the entire teaching burden, in a course involving the teaching of a body of factual information.

Procedure

Three comparable groups of ninth-grade high school students were taught a four-unit course in general science over a period of a full semester. One group was taught by being shown a series of 44 films alone, about 11 per teaching unit. The second group was taught by being shown these films, and by studying, before and after each film, specially prepared short study guides. The third group was taught by teachers using a standard textbook, and customary classroom teaching techniques (other than films).

The students were given objective-type tests immediately at the end of each unit, and a retention test covering all four units three months after the end of the course. They were also tested before and after the experiment with a standardized test of general science knowledge.

Results

The analysis of the test results for the three groups revealed that intermethod differences were small and generally not significant. The Films Only group in 6 out of 48 comparisons earned slightly lower mean scores than either of the other two groups in immediate recall tests, while both film groups performed slightly better than the Conventional method group on delayed recall tests. The Film plus Study Guides method was at least as effective as, and perhaps slightly more effective than, the other two methods, but the Films Only method differed so slightly from the Conventional method and the Films plus Study Guides method, that for all practical purposes, it may be concluded that the three methods were of almost equal effectiveness.

Conclusions

The overall results of this study suggest that a body of factual information such as high school general science, may be taught by films alone, almost as effectively as by a teacher using conventional classroom methods (except films), and by films introduced and supplemented by brief study guides perhaps a little more effectively than by conventional non-film teaching methods.

It should be borne in mind that the measure of effectiveness adopted in this study has been solely the learning of factual information. It may well be that teachers provide greater motivation, interest, and inspiration, and aid in the development of critical thinking ability through classroom discussions. Furthermore, it seems likely that instruction by teachers plus films, would be more effective than either method alone. On these points this study furnishes no reliable information.

Implications

The study clearly suggests that in mass training situations where the task is to impart a specific body of factual information a course of carefully produced films covering this information would result in as effective learning as a training course led by instructors using conventional methods. Such a procedure should help considerably to offset a shortage of expert instructors in an emergency situation.

RELATIVE EFFECTIVENESS OF INSTRUCTION BY:
FILMS EXCLUSIVELY, FILMS PLUS STUDY GUIDES, AND
STANDARD LECTURE METHODS

I. INTRODUCTION

The Problem

To what extent can motion pictures substitute for teachers? This is the question with which this research is concerned. A complete answer is not to be given by this single study, but a beginning has been made by determining the relative effectiveness of teaching elementary scientific facts and principles to classes of ninth grade students (a) by means of motion pictures (with and without preparatory study guides), with the teachers of those students doing no more than taking attendance, maintaining order, and operating a schedule of motion pictures, and (b) by conventional methods in which the teacher provides intellectual leadership and all the usual materials of instruction except motion pictures.

The shortage of competent instructors and the lack of sufficient equipment for training purposes were two of the main problems facing those responsible for training personnel for the Armed Forces in the early days of World War II. One of the main reasons for the Instructional Film Research Program is the need for learning how motion pictures can, if the need arises, alleviate such shortages of instructors and equipment in any future emergency. It is appropriate that the main attack on this problem should deal with what makes an effective film. This has involved the original production of films, in a number of versions, with systematic variations of film characteristics and methods of presentation among the versions. The effects of these variations are then tested under experimentally controlled conditions. It seems equally reasonable, however, to determine as a corollary the extent to which existing films can do a complete teaching job by themselves. A comparison of the learning resulting from exclusive film instruction with that resulting from conventional teacher-mediated instruction should provide some notion as to the hopefulness or hopelessness of our main task. If, for example, it could be shown that groups of five hundred learners can be taught about as effectively with existing films alone as groups of forty can be taught by teachers without films, the chances of alleviating the instructor shortage would be very real.

The idea of using motion pictures to replace teachers in any part of their duties has been an anathema for decades--so much so that since the advent of the sound film very few research workers have ventured to investigate the possibility. In the mid-depression year of 1934, Stoddard¹ conducted an experiment in which he compared the effectiveness of teaching sixth grade pupils under three conditions: (a) in groups of 150 with films and all other usual teaching materials; (b) in groups of 40 with conventional teaching materials and no films; (c) in groups of 150 with conventional teaching materials and no films.

His findings were that sound motion pictures "must be considered a real factor in determining class size" and that groups of 150 would learn at least as much under a system where motion pictures supplement other teaching devices as groups of 40 learn under a system where sound motion pictures are not used.

Stoddard's investigation differed from the present study in that he made no attempt to eliminate the teacher as an intellectual force in the classroom. It is of course, helpful to know that a skilled instructor can use movies with groups of 150 nearly as well as with groups of 40. It would be even better to know that in some training situations a boatswain or a sergeant who knows nothing of the subject matter could supervise a training session in which the instruction would be given by means of films exclusively.

The Method of Attack

To determine whether in fact instructional films can carry the entire teaching burden, each of three comparable groups of ninth grade high school students was taught a one semester course in general science, by one of three methods. One group was taught by teachers using a standard science textbook, following conventional classroom procedures: this was the Conventional method group. The second group was taught by means of films, supplemented with brief study guides made up of introductory reading material and practice exercises: this was the Films Plus Study Guides group (referred to below as the Study Guides group). The third group was taught with films alone: this was the Films Only group. The relative effectiveness of the three methods was determined by comparing the mean scores of the three groups on tests designed to sample the general science areas covered.

¹ Stoddard, A. J. "Visual Aids and the Economic Situation" Educational Screen XIII (January, 1934), 13.

II. EXPERIMENTAL DESIGN AND PROCEDURES

In this chapter, the specific materials and procedures are described, and the characteristics of the experimental population are outlined.

The Subject Matter

It was felt that a meaningful and valid comparison among methods and materials of teaching might be prejudiced if the students were unfamiliar with any of the methods. Accordingly an entire semester was devoted to the experiment, in order to reduce the probability that any good or poor showing made by either of the film methods could be attributed to the novelty of either experimental method or materials.

It was also believed that the validity of the comparisons might be questioned if the particular science information to be taught were selected on the basis of its susceptibility to communication by motion pictures, or on the basis of the assumed quality of existing films on that subject matter area. Accordingly, the participating teachers were asked to decide what subject matter they would teach during the whole semester before they were told anything regarding the nature of the experiment.

The first step in conducting the experiment was to call a meeting of all science teachers who might be involved in the study. These teachers were asked if they were willing to participate in an educational experiment that would involve their classes for a full semester. It was explained that a detailed understanding of the experiment on their part might prejudice the results and that, therefore, their acceptance or rejection of the experiment was requested before they could be told exactly what would be entailed. When the teachers agreed unanimously to cooperate, they were asked to decide what subject matter they would cover during the fall semester 1948-49. All agreed to teach the same sections of a common textbook, Science Problems² by Beauchamp, Mayfield, and West. After some discussion five units of work were selected by the teachers, who then agreed upon the order of presentation and time allotments shown in Table I. A formula of readability³ was applied to a random sample of five pages of each unit covered in the experiment. The predicted readability level for the textbook was at grade seven or eight.

² Chicago, Illinois: Scott Foresman Co. 1939

³ Chall, Doris and Dale, Edgar. "A Formula for Predicting Readability." Educational Research Bulletin, XXVII (January 21, 1948) 11-20.

It was only after the foregoing course of study had been agreed upon that the teachers were informed that the experiment would involve teaching by film. It can be said, therefore, that in no respect was the subject matter covered in the experiment selected with a view to making the films show up well. On the contrary, the selection was made by applying the criterion that participating teachers normally apply in curriculum building: their estimate of the validity of subject matter for the aims and purposes of education in their own school system. The subject matter content of the experiment was representative of that commonly taught in the general science curriculum.

One additional agreement regarding the experiment was made by the science teachers at their first meeting; namely, that there would be no review of the experimental subject matter between the close of the experimental period at the end of the first semester and the administration of a retention test three months later.

A detailed account of the science information communicated to students during the experiment can hardly be included in this report. Approximately 339 pages of the science textbook were covered, but the teachers operating under the conventional teaching system availed themselves of their prerogative to introduce non-textbook material. The exact amount and nature of this material is unknown. On the other hand, the curriculum of the two groups taught by films is fairly accurately defined by the forty-four films used in the experiment.

Although the teachers originally planned to cover five units of work during the semester, it was discovered after approximately eight weeks of the semester had passed that emergency vacations, early dismissals of school, and similar interruptions would prevent covering all five units. The unit on Simple Machines was the shortest and its planned duration matched closely the predicted loss of teaching days for the semester, so it was dropped. Thus the unit on "Electricity" followed the unit on "Elementary Psychology."

It should be clear at this point that the factual content for the groups taught by the conventional method was not identical to that taught by films plus study-guides or by films alone. The films used in the experiment, however, were selected mainly in terms of their coverage of the content covered in the textbook units. There is, therefore, a large but necessarily inexact delimited body of science subject matter common to the conventional and film methods. On the other hand, there are areas of the textbook which are not covered in the films and there are facts in the films which are not included in the textbook. Furthermore, there are differences in the relative emphasis given by films and textbook on points common to both instructional media.

The Films

The films used were selected partly on the basis of their appropriateness to the content of the textbook units that had been agreed upon by the science teachers. It will be remembered that these units were chosen without reference to the susceptibility of the content to film presentation or the number or quality of available films. Subject matter content, therefore, was the first criterion for film selection.

By searching the various film indexes and catalogs and by addressing letters of inquiry to major film producers and distributors, approximately two hundred films were located that seemed to satisfy the criterion of relevancy to textbook subject matter. Subsequent screenings revealed a sufficient number of films having overlapping content to justify the employment of secondary criteria of selection. These criteria were as follows:

- a. Technical quality: Preference was given to those films with more distinct sound and clearer pictures.
- b. Grade level: Films that appeared too complex or too advanced were eliminated first; those that were too simple were eliminated second. If no film on a given subject appeared to be at just the right grade level, one aimed at a grade lower than the ninth was preferred over a more advanced film.
- c. Accuracy: Films which were judged to portray erroneous ideas were avoided.
- d. Organization: Preference was given to films having well defined introductions and conclusions, and those in which the content was organized in a clearly recognizable system.

Forty-four films were selected for use in the four units that were taught during the experiment. The titles, sources, and physical characteristics of these films, and their distribution among the teaching units, are listed in Appendix A. Only four were longer than one reel. Five of the forty-four were in color. Four were silent films. Copyright dates ranged from 1930 to 1948; the median being 1938. Sixty-nine percent of the films were furnished by three producers: Encyclopaedia Britannica, Coronet, and Young America. The remaining 31 percent were furnished by six other film producing or distributing agencies.

TABLE I
NUMBER OF CLASS PERIODS FOR EACH TEACHING UNIT

Number of Periods Allotted	Name of Unit
13	How are Plants and Animals Fitted to the Conditions Around Them? (Adaptation)
15	How Do Scientists Classify Living Things? (Classification)
10	How Do Living Things Behave? (Elementary Psychology)
9	How Do Simple Machines Help Us Do Work? ^a
12	How Do We Make and Use Electrical Current? (Elementary Electricity)

^a This unit was subsequently eliminated because of loss of school time due to impromptu assemblies, early dismissals, etc.

Note: In the statistical tables the units are identified by the titles included in parentheses.

The Experimental Methods

The Conventional method. The Conventional method involved, beyond the agreement to use the same textbook, no special procedures differing from those usually employed by classroom teachers. To ensure some degree of comparability among the three methods groups, and to avoid the possibility of overlapping methodologies, however, two restrictions were imposed upon the two teachers responsible for the Conventional method classes. These teachers were (a) to complete each unit in the number of teaching days shown in Table I and agreed upon in the original planning conference, and (b) to avoid the use of motion pictures.

Each teacher was asked to keep a log of class activities. Examination of these logs and frequent class visits by the writer revealed that the greater part of the learning activities were centered around the textbook. Each student in the Conventional method group had his own textbook and was permitted complete and unrestricted custody of it for the duration of the school year. Students were given reading assignments in sections of the textbook relating to various topics; then the content of the assignments was "discussed." The "discussion" consisted of students' answers to teachers' questions, teachers' elaborations on certain facts, students' reactions to the lesson, and so on. There was some use of such visual aids as models, specimens, and charts, especially in the two biological units on adaptations and classification of living things. Demonstrations were conducted by the teacher principally in the study of electricity.

While it cannot be proved that the teaching done under the conventional method was truly excellent or inspired, in the opinion of the writer, himself a former science teacher, it was at least average in quality.

The classes were held in a room especially designed for science teaching. There was a high demonstration table with electrical connections, sink, and gas supply. Supply cupboards on the walls contained specimens, models, and demonstration materials and equipment. There were charts and diagrams in the front of the room. A blackboard extended across the front wall. Lighting and ventilation were good.

Of the two classes exposed to the Conventional method, one met during the third of four morning periods. The other met during the last of three periods in the afternoon. All periods were of fifty minutes duration.

The Films Only method. Two different methods of filmic instruction were used in the experiment. Both were intended to be applicable to large group instructional situations although they were actually employed in classes of the usual size; that is, about forty students.

The Films Only method was aimed at placing the entire teaching burden on the films. All instruction under this method was supplied by films; the learning activity consisted solely in viewing films. The teacher did no more than to take roll, maintain order, and see that each film was shown twice according to a pre-determined schedule. The plan was designed to permit the showing of the complete list of films as rapidly as possible. A typical week's schedule was as follows:

Films Only Teaching Plan

Day	Date	Film Title	Running Time
Monday	Oct. 4	Mammals of the Rocky Mountains Mammals of the Plains	22 min.
Tuesday	Oct. 5	Animals in Modern Life Mammals of the Plains Seed Dispersal	33 min.
Wednesday	Oct. 6	Animals in Modern Life Control of Body Temperature Flowers at Work	33min.
Thursday	Oct. 7	Seed Dispersal How Animals Defend Themselves Flowers at Work	33 min.
Friday	Oct. 8	No class scheduled	

It will be observed that while each film was shown twice, no film was shown the second time immediately following the first showing. No brief is made for this action; it merely seemed that such a plan would provide for greater interest and, consequently, more efficient teaching and learning. It is recognized, however, that some confusion may have resulted.

Totalling the running times of films shown in a given day reveals that in no case do they add up to a full fifty minute period. The question might be asked: what happened to the remaining time? It was spent in roll taking, in reading routine school announcements, and in rethreading the projector. When it was apparent that this non-science business would not "fill the period", the start of the first film showing was delayed long enough to make the last film coterminous with the end of the period. During the delay, the students were permitted orderly "free activity." Most of them conversed among themselves or read for pleasure or information. Science textbooks were not available nor permitted, however.

The Films Plus Study Guides method. The second method of filmic instruction was the Films Plus Study Guides method, the pattern of which was dictated by three hypotheses regarding learning: (a) information presented by films will be learned more completely if the learner verbalizes some of it, (b) non-filmic preparation for film viewing will improve learning from films, and (c) learning from films will be more efficient if the learner is able to appraise his learning. As in the Films Only method, each film was shown twice. Before each showing, whether it was the first or second viewing of the film, students prepared themselves by referring to especially prepared study-guides. After each showing the students answered questions or corrected previously given answers to questions based on the film's content. This method used the same films as the Films Only method.

Several typical study guides will be found in Appendix B. It will be observed that each study guide provided for several types of student preparation for film viewing: (a) a rudimentary understanding of the general purposes of the film, and therefore, the lesson, (b) preliminary definitions of vocabulary items that seemed prerequisite to better understanding of the film, and (c) a survey of the important facts to be learned from the film as reflected in the study guide's questions.

Answering the questions in the study guide, and, in a sense, reading the study guide forced the learner to verbalize at least a part of the information gained from the film.

During the first unit, each student was permitted to keep his own study guides in a special notebook supplied to him. Following the second showing of a film, students were encouraged to reconsider their answers to study guide questions.

In the final three units the method was slightly revised because the students were taking a rather cavalier attitude toward the study guides. Beginning with Unit II, the study guides were collected and checked by clerks at the end of each period. A percentage grade was entered, and the wrong answers were indicated, but correct answers were not supplied. The graded study guide was then returned to the student prior to his second film viewing, at which time it served as an additional aid in his pre-film preparation. This action was believed to contribute to the reinforcement of correct answers, the inhibition of wrong answers, and the general motivation for learning from the second film showing. The student was kept informed of his progress in learning; yet the method was applicable to large group instruction.

A typical sequence of instruction was as follows:

Films Plus Study Guides Plan

Date	Activities	Time Allotment (minutes)
October 4	Review study guide for film "How Nature Protects Animals" (Shown yesterday for the first time)	3
	See "How Nature Protects Animals" a second time	11
	Check wrong and omitted study guide questions	5
	Read study guide for "How Animals Defend Themselves"	5
	View film "How Animals Defend Themselves" for the first time	11
	Answer study guide questions on "How Animals Defend Themselves"	10
October 5	Review study guide for "How Animals Defend Themselves"	3
	See "How Animals Defend Themselves" a second time	11
	Check wrong and omitted answers on study guide	5
	Read study guide on "Mammals of the Rocky Mountains"	5
	View "Mammals of the Rocky Mountains"	11
	Answer questions in study guide "Mammals of the Rocky Mountains"	10

Two possible limitations of the study guide method were recognized at the outset: (a) the use of a study guide which did not include all the information in the film might inhibit learning of those film items omitted from the study guide, and (b) the use of a study guide might tend to structure the learner's technique of learning from films, which might in turn make him less effective in a film learning situation in which study guides were not furnished. Since all the tests of learning that were used for this experiment were developed independently of the construction of the study guides, it was believed that a comparison of achievement of the Films Only group and the Films Plus Study Guides group would furnish a partial test of the validity of the first possible objection to the use of study guides in film instruction. The second possible objection was tested in a supplementary experiment which will be described in another report.

The teachers. Five teachers--four men and one woman--were assigned by the administration of the Bellefonte Public Schools to general science instruction in the ninth grade. There is little doubt that they differed somewhat in their teaching ability. There was no question, however, that all were well able to maintain order in the classes to which they were assigned. Since it was important, however, that the Conventional method classes be presided over by teachers who were at least as competent as the average, it was decided in conference with the school's responsible administrative officers that teachers A and B would serve. Teacher A was a man with more than ten years experience in teaching general science. All who knew him felt that he had an adequate knowledge of his subject and a high degree of skill in teaching it. Teacher B was a young woman recently graduated from college. Her preparation had included science teaching, and she was thought to be a conscientious, skillful, and imaginative science teacher although she lacked prolonged experience.

The remaining three teachers were men with from two to eight years of experience. None had taught ninth grade science the previous year, but all had taught other courses in the Bellefonte schools. Two of these teachers were assigned one class each. The third had two classes, one of which was in the Films Plus Study Guide method, and the other, the Films Only method.

Comparison of teaching time for the three methods. The time required for each of the three methods constituted an important experimental problem. The length of time that teachers had decided would be required to cover each unit under the Conventional method was used to determine the number of films to be shown, and, therefore, the maximum amount of time allotted to the film methods.

Table 2 shows the actual number of periods devoted to each unit under each method of instruction. The slight variations between Conventional and Films Plus Study Guides methods in time spent on some units reflect errors in estimating the time that would be required for the Conventional method group to complete a given unit, or in the addition or subtraction of a single film in the Film Plus Study Guide method group.

The total number of class periods during which the experimental program was in operation was substantially the same for Conventional and Study Guide methods. However, a considerably shorter instructional period was characteristic of the Films Only group, for while the Study Guide method was equated with the Conventional method with respect to time, it was not so equated with the Films Only method although the same films were used. Thus, the time spent on study guides was saved in the Films Only method, and, as a result, this method consumed only about 80% of the time required for the other two methods.

Supervision and record keeping. Constant supervision was necessary to insure that standard experimental conditions were observed, and that extraneous school conditions did not give any group or groups either an advantage or a handicap. Supervision was supplied in several ways. First, the writer made daily visits to classrooms during the first three weeks of the experiment. During subsequent weeks supervisory visits were made at least twice each week. Second, the Director of Visual Education in the school where the experiment was conducted had been drawn into the conduct of the experiment during its initial planning period. A share of his time was used for supervision. Third, the school Superintendent and secondary school Principal cooperated in matters of scheduling and supervision.

In addition to direct supervision, each of the teachers was asked to keep a daily log of occurrences in the experimental classes. Notations were made of absences, interruptions, and unusual occurrences. Furthermore, a brief anecdotal description of each day's activities was written by each teacher.

Table 3 shows that the extent of absenteeism among the various units and groups was practically equal. It should be understood, however, that results from the filmic methods were probably more likely to be adversely affected by a given level of absenteeism than were results of conventional teaching methods. This condition is due to the fact that it was relatively easy for students in the Conventional method group to "make up" classwork missed, since each of them had a textbook that he could study at home, during or after absences. By the same token, the study guides did contribute something toward the amelioration of a student's loss of class time. It was not feasible to conduct make-up showings of films, however, so a class period missed in a film group was simply a learning experience lost.

TABLE 2
NUMBER OF PERIODS OF STUDY DEVOTED TO EACH UNIT^a

Method	Conventional		Study Guide		Films Only	
Class	3	4	1	6	2	5
Unit						
Adaptations	12	12	11	13	9	8
Classification	14	12	14	14	10	10
Elementary Psychology	11	10	9	9	8	9
Elementary Electricity	<u>11</u>	<u>12</u>	<u>11</u>	<u>12</u>	<u>11</u>	<u>9</u>
Total	48	46	45	48	38	36

^a Exclusive of periods for testing.

TABLE 3
PUPIL-DAY ABSENTEEISM, BY TEACHING
UNIT, CLASS, AND METHOD GROUP

METHOD	Conventional		Study Guide			Films Only	
CLASS	3	4	1	6	5	2	
Unit I							
Pupil-days absent	17	21	15	10	14	10	
Number of pupils absent one or more days	9	14	7	8	12	8	
Unit II							
Pupil-days absent	16	43	15	20	23	35	
Number of pupils absent one or more days	11	20	13	15	20	18	
Unit III							
Pupil-days absent	7	27	20	27	8	23	
Number of pupils absent one or more days	7	19	12	16	8	14	
Unit IV							
Pupil-days absent	38	29	28	24	17	51	
Number of pupils absent one or more days	17	14	14	15	10	26	
Total Pupil-days absent	78	120	78	81	62	119	
Total Pupil-days absent for Method group	198		159		181		
Total number of pupil-days available	6851		5867		6779		
Per cent absenteeism	2.89%		2.71%		2.67%		

It has been pointed out previously that unanticipated interruptions of the school program were sufficient in number to force the elimination of one of the five units originally planned for the experiment. Fortunately, the school administration adopted a policy of rotating the order of succession of class periods, so that no single class missed more meetings than any other.

A review of class logs reveals no pattern of unusual occurrences that might appear to weigh significantly in favor of, or against any experimental group. There were a number of notations regarding faulty projector performance during the first two units of study, but it was the opinion of the teachers that learning was not seriously impeded. Also, an extended trip by members of the School Band cut into the first units, but fortunately about equal numbers were drawn from each group. This fact is, of course, verifiable in the records of absenteeism, shown in Table 3, for those records were kept independent of school and state regulations as to definitions of absences. That is, if an individual student was not present, he was listed as absent for experimental purposes regardless of the fact that official school records might have shown him to be present.

The Tests

Four sets of tests were used for various purposes in the experiment: (a) One set of tests, hereafter called "Equating Tests", was used to determine the equivalence of the groups with respect to intelligence and science achievement before the experimental instructional period began. (b) Separate tests, hereafter called "Unit Tests", were administered to each group as it completed each unit of instruction. (c) A second form of the standardized science achievement test included in the equating tests battery was administered at the end of the experimental instruction period. (d) A fourth test, hereafter referred to as the "Retention Test", consisted of a selection of items from the unit tests. It was administered three months after the end of the experiment.

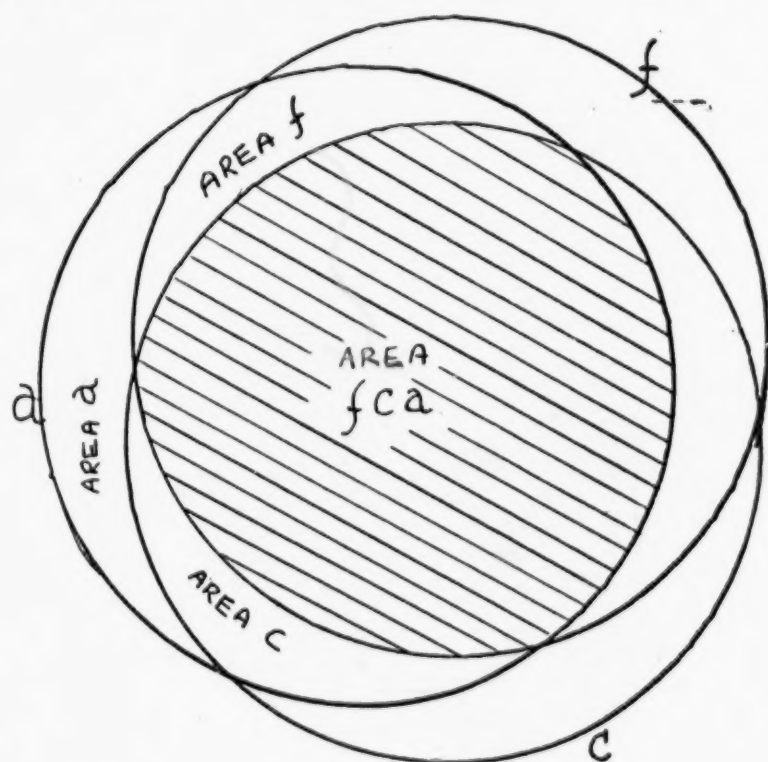
The equating tests. The test used as a measure of intelligence was the California Test of Mental Maturity, S Form, 1947.⁴ This test is made up of four parts that measure non-language factors of intelligence, and three parts that measure language factors. The total test has an aggregate time limit of 62 minutes of which 22 are devoted to non-language measures. The test has a validity of .88 (correlation with Stanford-Binet).

⁴ California Test Bureau, Los Angeles, California

The test of science achievement used in this study was the Calvert Science Information Test, Intermediate Form. It was selected because (a) it seems to be a reasonably valid measure of science achievement and (b) it has two equivalent forms. The coefficient of reliability based on the split-half technique is .90.⁵

The Calvert test is not a timed test; however, all students completed it in the space of forty minutes.

The unit tests. Whereas it was possible to find equating tests that were standardized, it was not possible to find such tests to measure the learning of information in the specific units taught during this experiment. Accordingly, tests had to be constructed. This posed a problem: how could such tests be constructed without favoring either the Conventional method or one of the film methods? Tests based upon either films or the textbook alone would be obviously unsuitable due to bias. A test consisting of items drawn from the content of both film and book might fail to measure an adequate sample of learning; and worse, would have to be proved to contain equal weighting for film and textbook content. The solution, admittedly imperfect, was to consider each unit as an absolutely defined body of scientific knowledge which the test could sample regardless of the extent to which it was covered in either films or the conventional method. The situation can be diagrammed as shown in Figure 1.



Circle a= total subject matter in tests

Circle f= subject matter covered by films

Circle c= subject matter taught in conventional method

Figure 1

⁵ California Test Bureau, Manual of Directions, Calvert Science Information Tests; 1937. p2.

Circle a defines the unit of subject matter absolutely, and the total unit test samples the whole unit as so defined. Circle f defines the subject matter covered by the films, and circle c represents the subject matter covered in the Conventional teaching method. The shaded area fca then is that subject matter common to film and non-film methods that is covered in the test. In addition, the test includes items covered in films only (area f), in the conventional method only, (area c) and in neither (area a).

The process of constructing the first two unit tests (on adaptations and classifications of living things) was as follows: a competent biologist⁶ was given the names of the units of study, and asked to list what he considered to be the approximately one hundred most important statements of facts, principles, or concepts that should, in his opinion, be included in each of the units. He was not given either the textbook or the films to use as reference material. These statements were then converted into multiple choice test items, approximately on the basis of one item per statement. These test items were then resubmitted to a second biologist⁷ who checked them for accuracy, ambiguity, and face validity.

The third unit test (on elementary psychology) was constructed in a manner similar to that employed for the first two tests, except that the subject matter expert, a professor of psychology, preferred to work directly in multiple choice test items rather than to begin with statements which could then be converted to test items.

The fourth test, on electricity, consisted of previously prepared items on elementary electricity used in another study⁸ supplemented by items developed and considered appropriate by a graduate in electrical engineering.

At the close of each unit, each teacher was shown the tests and asked to indicate which test items were not covered in his own class. Items which were not checked by any teacher were considered to be common to both film and conventional methods. As a result of this procedure it was believed that the content taught both by the films and the conventional method was reasonably well defined. The tests therefore could be and were scored in two parts; one part consisted of items covered by all methods, the other of items covered in only one method or not at all.

⁶ This man had earned his M.S. degree in biological science and was working on his Ph.D.

⁷ This man was a professor of Zoology, with a Ph.D. in that field.

⁸ Brown, James W. (Thesis)

Table 4 shows the number of items in each part of each test and the reliability coefficient as computed for each total test.

The test of general achievement in science. Form B of the Calvert Test used in the equating test battery was administered at the end of the instructional period. Thus, for the Conventional and Films Plus Study Guide groups the Calvert Form B was given at the end of the first semester, 1948-49. The Films Only method group took the test about a month earlier, just before the Christmas holiday.

The retention test. The retention test was made by selecting certain items from each of the four Unit Tests. It was first decided that the test should be administered in a single period. Previous experience indicated that an eighty-item test could be administered conveniently.

It was further desired to give each unit equal weight in the Retention Test. Consequently, exactly twenty questions were selected from each Unit Test. The selection of test items was made so as (a) to include those items with the greatest validity as determined by the magnitude of their correlation with scores on the total test,⁹ and (b) to include a range of difficulty from 10 to 90 per cent.

In the actual selection of items from the Unit Tests, the items having an item-test correlation of .27 or greater were listed according to the percentage passing the item in ten intervals of 9 per cent ranging from 11 to 90 per cent inclusive. The two items having the highest item-test correlation were selected from each interval.

In a few instances, there were not two test items in an interval that met the criterion of an item-test correlation of .27. In such cases an item was selected from an adjacent interval balanced by a corresponding selection of items from intervals equidistant from the mean of 50 per cent level of difficulty.

As a test of reliability, a second retention test was made up using the same procedure, and administered to the experimental population the day following the administration of the main retention test. The correlation between these two test was .86.

⁹ Using the method suggested by Mosier, C. I. and McQuitty, J. V. Methods of Item Validation and Abacs for Item-Test Correlation and Critical Ratio of Upper-Lower Difference, Psychometrika, 1940, 5, 57-66.

TABLE 4
CHARACTERISTICS OF UNIT TESTS: RELIABILITY, TOTAL NUMBER
OF ITEMS TEACHERS BELIEVED TO BE COMMON TO ALL METHODS

UNIT	Adaptations of Living Things	Classification of Living Things	Elementary Psychology	Elementary Electricity
Reliability ¹	.86	.72	.79	.85
Total Items	97	88	95	68
Items Common to all Methods	36	24	32	33

¹ Reliability computed by Kuder-Richardson formula 20:
$$r_k = \frac{n}{n-1} \left(1 - \frac{\sum t^2}{n \sum p q} \right)$$

The Experimental Population

The entire ninth grade class of the Bellefonte (Pennsylvania) Public Schools participated in the experiment. The ages of the students involved ranged from 12 to 18 years at the beginning of the experiment. The mean age was about 14 years. The mean intelligence quotient was between 100 and 105, with a range from about 70 to 140. Boys were slightly outnumbered by girls. The subjects lived in a small city or came to school in buses from neighboring villages and farms. In general, the subjects were not far from typical of students in other northern, unsegregated public secondary schools.

The classes were conducted in groups of approximately forty; the range being from 38 to 45. Two such classes were taught by the Conventional method, two by the Films Plus Study Guides method, and two by the Films Only method.

The students normally would schedule general science in one of six sections. The particular section to which an individual student was assigned would usually depend upon his curriculum; that is, whether he was college preparatory, general, or vocational student. As would be expected, there were originally sizeable differences among sections as to mean age, science aptitude or achievement, intelligence, and relative numbers of boys and girls. It was necessary, therefore, to shift students around among sections in an effort to equalize the sections in terms of those factors which seemed most likely to influence the amount of learning to be expected in science. It was impossible, however, to effect adequate equating of sections by such shifting of students, because conflicts would have developed in the schedules of many students who should have been shifted from one section to another for equating purposes. It developed later, furthermore, that the number and character of students who left school during the course of the experiment was such that even had the equating been satisfactory at the beginning of the experiment, it would no longer have been so at the end. Accordingly, in addition to the preliminary rough equation of groups by the shifting of students among sections, a few students who deviated very greatly from the group norms were eliminated from statistical consideration. Students who for one reason or another did not take all the tests, or were absent for more than 25 per cent of the time devoted to any instructional unit were also eliminated, causing a reduction in numbers of subjects from 268 on whom initial data were gathered to 196, the number used in final statistical computations.

Comparability of the three methods groups. Data regarding the equivalence of the experimental methods groups are presented in Table 5.

Table 5 reveals that, on the average, the subjects (combined sexes) who were to be taught by the Conventional method had a higher mean mental age, and scored higher on both the language and non-language parts of the California test, than subjects in either of the film groups; subjects in the Study Guides group scored between the Conventional method group and the Films Only group; on these three measures the Films Only group was consistently lower. On the other hand, the order of the group means was reversed for the science information test scores. The Films Only group was first (highest) while the Conventional method group was lowest.

Sex differences within and among the methods groups. When the students were subdivided according to sex, a few statistically significant differences within and among the groups were noted with respect to measured intelligence and science background knowledge.

First, on each equating measure, for each method group, the boys consistently earned a higher mean score than the girls. The sex difference, on each measure, was of the order of almost one standard deviation, and was in each case significant at about the one per cent level of confidence. For this reason, the subsequent analysis includes inter-method comparisons for the two sexes separately, as well as for the sexes combined. It should be pointed out, however, that since the number of boys and girls in each method group is very similar (range of cases is 31-34), combining the two sexes does not result in methods means biased by disproportionate sex weighting.

Second, within each sex more or less consistent inter-methods differences were noted. These differences necessarily parallel those for the combined sexes. For the intelligence measures the order of the methods groups was Conventional (highest), Study Guides (in the middle), Films Only (lowest). This order was more or less consistently reversed for the science information test scores. With three exceptions, however, the intra-sex, inter-methods differences were not significantly different from zero at the 10 per cent level of confidence or better.

The exceptions were as follows: a. For girls, on the California non-language factors score, the mean difference between the Conventional method group and the Films Only group of 2.71 points in favor of the Conventional method group, was significant at the 5 percent level of confidence. b. For boys, on the Calvert Living Things subtest, the mean difference between the Films Plus Study Guides group and the Conventional method group of 3.68

TABLE 5

EQUATING MEASURES FOR THE THREE EXPERIMENTAL METHODS GROUPS:
MEANS AND STANDARD DEVIATIONS, BY SEX AND METHODS GROUPS

SEX	BOYS			GIRLS			COMBINED SEXES		
	Conven- tional	Study Guides	Films Only	Conven- tional	Study Guides	Films Only	Conven- tional	Study Guides	Films Only
METHOD									
Number of Cases	33	31	31	34	34	33	67	65	64
Chronological Age									
Mean	172	170	169	168	172	169	170	171	169
Mental Age (California)									
Mean	181.27	180.03	178.03	171.53	170.06	166.00	176.63	174.81	171.83
S. D.	13.67	16.92	19.70	12.98	16.74	20.04	12.15	17.55	20.77
California Language									
Mean	25.48	24.10	22.77	20.56	20.41	19.94	22.98	22.17	21.31
S. D.	5.16	7.68	7.88	5.78	7.16	8.41	6.01	7.64	8.28
California Non-Language									
Mean	30.82	31.64	31.68	29.74	28.79	27.03	30.27	30.15	29.28
S. D.	5.62	6.21	6.48	5.30	5.79	6.51	5.48	6.16	6.90
Calvert Living Things (Form A)									
Mean	28.00	31.68	28.58	23.76	22.09	26.48	25.85	26.66	27.50
S. D.	6.23	6.49	7.67	6.07	8.63	7.95	6.50	9.06	7.89
Calvert Total Science (Form A)									
Mean	65.76	69.32	64.35	53.12	52.09	58.30	59.34	60.03	61.23
S. D.	11.47	13.59	16.54	12.48	15.49	16.10	13.56	17.78	16.59

points in favor of the Study Guides group, was significant at the 2 per cent level of confidence. c. For boys and girls, considered separately, the mean differences between the Study Guides groups and the Films Only groups, in favor of the Study Guides groups, were significant at the 10 per cent level (boys) and the 5 per cent level (girls) of confidence respectively.

This analysis of the initial status of the groups suggests that, both within the two sexes and for the combined sexes, a reasonable degree of comparability was attained. The consistent general intellectual inferiority of the Films Only group is probably compensated for by the superiority of this group on the science information tests. It is, therefore, probable that the net effect of these differences in initial status on the film performance test is negligible.

III. RESULTS OF THE EXPERIMENT

Three separate measures of the relative effectiveness of the three teaching methods are available: (1) scores on the four unit tests based (a) on all the items in each test and (b) on only those items judged to be common to the three methods; (2) scores on the delayed recall test that covered all four teaching units; and (3) end-of-semester scores on the Calvert (Form B), Science Achievement Test (for comparison with pre-test performance on Form A). For each test, the mean inter-method differences were calculated for every possible comparison, and the probability that each observed difference exceeded a true difference of zero was determined.

In general, it may be said that the Films Only method group did poorest on the various tests, the Conventional method group's performance was second, and the Films Plus Study Guides method group's performance was best. However, this order was not always found, and, of the 108 differences calculated, for all comparisons, only 35 were significantly greater than zero at the 10 per cent level of confidence or better, and only 15 were significantly greater than zero at the 2 per cent level of confidence or better. An overview of the results suggests that, while there may be a trend indicating a slight inferiority of the Films Only method, for all practical purposes the three methods are of about equal effectiveness. The results of the three tests will be discussed separately below.

The Unit Tests - All Items

The means and standard deviations, based on all items, for the tests on the four leading units are presented in Table 6, and the inter-method differences are presented in Table 7. It will be observed that, for each unit, the test was in each case at about the 50 per cent level of difficulty, i. e., the mean score was generally about half the number of items on the test.

Unit on "Adaptions". None of the inter-method differences, for each sex separately or for the sexes combined, was significant at the 10 per cent level or better. The Films Only group was, however, consistently lower than either of the other two groups, the difference being between a tenth and a third of a standard deviation. For each method, the inter-sex difference was large in favor of the boys (larger than any inter-method difference), and probably significantly greater than zero.

UNIT TEST RESULTS, BASED ON ALL ITEMS
MEANS AND STANDARD DEVIATIONS, BY SEX AND METHODS GROUPS

S E X	B O Y S				G I R L S				COMBINED SEXES			
	Conven- tional	Study Guides	Films Only		Conven- tional	Study Guides	Films Only		Conven- tional	Study Guides	Films Only	
METHOD												
Number of Cases	33	31	31		34	34	33		67	65	64	
Adaptations												
Mean	48.82	47.71	44.97		41.21	41.50	40.27		44.96	44.38	42.96	
S. D.	10.49	9.51	11.15		11.57	11.54	10.95		11.69	11.38	11.29	
Classification												
Mean	39.00	39.26	34.29		36.38	35.32	33.82		37.67	37.20	34.05	
S. D.	8.29	6.91	6.75		6.34	7.87	6.93		7.48	7.68	6.85	
Elementary Psychology												
Mean	38.48	42.10	36.58		36.74	37.09	36.61		37.60	39.48	36.59	
S. D.	7.61	7.56	8.75		7.79	8.54	8.55		7.78	8.46	8.65	
Elementary Electricity												
Mean	34.67	38.94	34.80		25.56	28.71	27.42		30.25	33.58	31.00	
S. D.	6.47	7.69	10.11		7.30	7.61	8.25		8.38	9.20	9.91	

TABLE 7

DIFFERENCES AMONG METHODS MEANS FOR THE FOUR
UNIT TESTS, BASED ON TOTAL TEST SCORES

	B O Y S			G I R L S			COMBINED SEXES		
	Conven- tional	Study Guides	Films Only	Conven- tional	Study Guides	Films Only	Conven- tional	Study Guides	Films Only
Adaptations									
Conventional	----	----	----	----	----	----	----	----	----
Study Guides	-1.11	----	----	+ .29	----	----	-.58	----	----
Films Only	-3.85	-2.74	----	-.94	-1.23	----	-2.41	-1.83	----
Classification									
Conventional	----	----	----	----	----	----	----	----	----
Study Guides	+ .26	----	----	-1.06	----	----	-.47	----	----
Films Only	-4.71 ^c	-4.97 ^d	----	-2.56	-1.50	----	-3.62 ^d	-3.15 ^c	----
Elementary Psychology									
Conventional	----	----	----	----	----	----	----	----	----
Study Guides	+3.61 ^a	----	----	+ .35	----	----	+1.88	----	----
Films Only	-1.90	-5.52 ^b	----	-.13	-.48	----	-1.01	-2.89 ^a	----
Elementary Electricity									
Conventional	----	----	----	----	----	----	----	----	----
Study Guides	+4.27 ^b	----	----	+3.15 ^a	----	----	+3.33 ^b	----	----
Films Only	+ .13	-4.13 ^a	----	+1.86	-1.29	----	+ .75	-3.58	----

NOTE: The sign of the difference is determined by subtracting the mean for the group at the top of the column from the mean of the group at the side of the row.

- a significant at the 10% level of confidence
 b significant at the 5% level of confidence
 c significant at the 2% level of confidence
 d significant at the 1% level of confidence

Unit on "Classification". The Films Only group was consistently lower than the other two groups. The differences were significant at the 1 or 2 per cent level for boys and for the combined sample, but not for the girls. It should be noted that the results for the combined sample (here and in all other comparisons) are simply mean values for the boys plus the girls. For each method, the inter-sex difference, favoring the boys, was about as large as the largest inter-method difference.

Unit on "Elementary Psychology". The Films Only group means were consistently lower than those for the other two groups, and in the case of the Study Guides/Films Only comparison, for boys, this difference was significant at the 5 percent level of confidence. The Study Guides group was consistently better than the other two groups. The inter-sex differences for this unit were small, in favor of the boys, except on the Films Only method, where the sexes were about equal.

Unit on "Elementary Electricity". For both sexes the Films Only method group mean was higher (but not significantly so) than the Conventional method group mean, and lower than the Study Guides group mean. The Study Guides method group mean was, for each sex, significantly higher (at the 5 or 10 per cent level) than the Conventional method group mean. For each method, the inter-sex difference was considerably larger than any inter-method difference.

The Unit Tests - Items Common to All Methods

It will be remembered that the content included in the textbook used in the Conventional method group was the primary basis on which motion pictures were selected for the various film groups. In spite of this fact, however, there were areas not covered in the Conventional teaching that were covered in the film teaching and vice versa. The total unit test scores sampled all these areas.

At the end of each unit each teacher was given a test booklet and asked to check those items which were not "covered" in his class. Those items which were not checked by any teacher were considered to be the common subject matter for all three groups. Table 8 presents the means and standard deviations and Table 9 the inter-method differences for these rigorously defined items common to all methods.

In general, the distribution of mean differences for these subsets of items follows closely that for the total item sets for each teaching unit. For the three units, "Adaptations", "Elementary Psychology", and "Elementary Electricity" the inter-method differences are, for the most part, not significant at the 10 per cent level or better. For each method, for each of the four

TABLE 8
UNIT TEST RESULTS, BASED ON ITEMS COMMON TO FILM AND CONVENTIONAL METHODS:
MEANS AND STANDARD DEVIATIONS, BY SEX AND METHODS-GROUPS

SEX METHOD	B O Y S			G I R L S			COMBINED SEXES		
	Conven- tional	Study Guides	Films Only	Conven- tional	Study Guides	Films Only	Conven- tional	Study Guides	Films Only
Number of Cases	33	31	31	34	34	33	67	65	64
Adaptations									
Mean	19.97	19.87	18.16	16.79	17.62	16.18	18.36	18.69	17.14
S. D.	5.23	5.11	5.24	5.72	5.05	5.18	5.71	5.20	5.31
Classification									
Mean	13.12	12.03	9.29	12.91	9.97	9.24	13.01	10.95	9.27
S. D.	4.04	2.66	2.34	3.70	3.06	2.87	3.87	3.06	2.63
Elementary Psychology									
Mean	15.33	15.94	14.84	14.62	15.26	14.21	14.97	15.58	14.52
S. D.	4.02	3.97	4.44	4.21	4.56	4.23	4.13	4.30	4.34
Elementary Electricity									
Mean	18.97	21.32	19.52	15.09	16.21	16.03	17.10	18.64	17.72
S. D.	3.91	4.28	5.82	4.49	4.92	4.96	4.68	5.28	5.67

DIFFERENCES AMONG METHODS MEANS FOR THE FOUR UNIT TESTS, BASED
ON SCORES FOR ITEMS COMMON TO THE CONVENTIONAL AND FILM METHODS

	B O Y S			G I R L S			COMBINED SEXES		
	Conven- tional	Study Guides	Films Only	Conven- tional	Study Guides	Films Only	Conven- tional	Study Guides	Films Only
Adaptations									
Conventional	----	----	----	----	----	----	----	----	----
Study Guides	- .10	----		+ .83	----		+ .33	----	
Films Only	-1.81	-1.71	----	- .61	-1.44	----	-1.22	-1.55 ^a	----
Classification									
Conventional	----	----	----	----	----	----	----	----	----
Study Guides	-1.09	----		-2.94 ^e	----		-2.06 ^e	----	
Films Only	-3.83 ^e	-2.74 ^e	----	-3.67 ^e	- .73	----	-3.74 ^e	-1.68 ^e	----
Elementary Psychology									
Conventional	----	----	----	----	----	----	----	----	----
Study Guides	+ .61	----		+ .66	----		+ .61	----	
Films Only	- .49	-1.10	----	- .41	-1.05	----	- .45	-1.06	----
Elementary Electricity									
Conventional	----	----	----	----	----	----	----	----	----
Study Guides	+2.35 ^b	----		+1.12	----		+1.54 ^a	----	
Films Only	+ .55	-1.80	----	+ .94	- .18	----	+ .62	- .93	----

NOTE: The sign of the difference is determined by subtracting the mean for the group at the top of the column from the mean of the group at the side of the row.

- ^a significant at the 10% level of confidence
^b significant at the 5% level of confidence
^e significant at the 0.1% level of confidence

units, the girls scored lower than the boys, and most of the inter-sex differences were larger than any of the inter-method differences. Since these subsets of items are necessarily correlated with the total item sets, this similarity in results is to be expected.

One slight departure from the results for the total item sets is worth noting. For the unit on "Classification", the Films Only group was consistently lower than either of the other two groups, for each sex, but significantly lower only for boys. On the common item subset, however, the differences between the Films Only method group and the other two groups were significant at the 0.1 per cent level of confidence, for both sexes. Furthermore, the Study Guides method group mean was lower than the mean for the Conventional method group. This difference was significant at the 0.1 per cent level of confidence for girls, but was not significant for boys. As a matter of fact, the unit on "Classification", is the only one presenting any nearly-consistent data favoring the Conventional method over the film methods.

Two explanations may be offered for this apparent superiority of the Conventional method. In the first place, the classification of plants or animals is made according to a system. No available film explained the system. On the contrary, the films on this subject were, at best, collections of descriptions of single groups of plants or animals, and there was nothing in them to give the learner a comprehensive grasp of the classification system with its logical morphological groupings. To a certain extent this weakness was compensated for by a "progress chart" used with Films Plus Study Guides groups, but there was no compensating factor operating in the favor of the Films Only group.

A second possible explanation for the superiority of the Conventional groups in this unit is the fact that of all of the units, that of the classification of plants and animals seemed to have the heaviest vocabulary burden. The sound films used were not well adapted to teaching the many new and often foreign-sounding names required in the classification of plants and animals. Where new technical words were introduced, very few films employed titles to supplement the sound track in communicating the word. Thus, the learner was subjected to the difficult task of translating a foreign-sounding word that he had only heard, not seen, to a printed or written word. Again, some compensation for this difficulty was built into the study guides in the form of vocabulary sections, but there was no such aid for the Films Only group.

Delayed Recall Test Results

The retention of science information presumably learned during the experimental period was measured by a test consisting of the twenty "best" items from each of the unit tests. This delayed recall test was administered

to each group exactly three calendar months after the completion of its experimental instructional period. By agreement, all of the teachers avoided discussion of concepts taught in the experimental units until after the delayed recall test was administered.

The results for this test are presented in Table 10. It may be noted, that for all the items included in this test as well as for the subset of items common to the three methods, both film groups were superior to the Conventional method group. This finding is interesting in view of the fact that both other groups were slightly superior to the Films Only group in terms of knowledge of the facts and principles as measured by the immediate recall tests. This is consistent with the findings of Rulon¹⁰ and most other investigators of the retention of film-mediated learning.

The differences favoring the film groups, however, are generally either marginally significant or not significantly different from zero.

The Films Plus Study Guides group's means were higher than the Films Only group's means, and for the boys, these differences were marginally significant.

In short, the delayed recall test, as opposed to the immediate recall test, suggests a slight but consistent superiority of both of the film methods over the conventional method, indicating that the long-run effects of film-mediated learning may counterbalance even the slight observed inferiority of the Films Only method on the immediate recall test.

The General Science Achievement Retest

Equivalent forms of the Calvert Science Information Tests were administered to all three methods groups at the beginning and end of the experimental instructional period in an effort to relate the students growth in science knowledge to some meaningful standard. Table 11 presents the means and standard deviations for the retest (Form B) and the differences among the retest means. Table 12 presents the differences among the mean gains for the three methods. The pretest means shown in Table 5 were used to calculate the mean gains. (e.g., retest Films Only minus pretest Films Only and retest Conventional minus pretest Conventional). Data is presented both for the total Calvert Science Achievement Test scores, and for scores based only on the "Living Things" Calvert sub-test. This latter score is essentially a measure of biological information.

¹⁰ Rulon, R. J., "The Sound Motion Picture in Science Teaching". Harvard Studies in Education, Vol. XX, Cambridge, Mass., Harvard University Press, 1933.

DELAYED RECALL TESTS ON TEACHING UNITS: MEANS, STANDARD DEVIATIONS, AND
 DIFFERENCES BETWEEN MEANS, FOR ITEMS COMMON TO THE CONVENTIONAL AND FILM
 METHODS, AND FOR ALL ITEMS, BY SEX AND METHOD

Means and Standard Deviations

SEX	BOYS							
	Conven- tional	Study Guides	Films Only	Conven- tional	Study Guides	Films Only	Conven- tional	Study Guides
Number of Cases	33	30	31	34	34	33	67	64
Common Items Mean	19.94	22.07	20.13	16.85	18.56	17.52	18.37	20.20
S. D.	4.60	4.34	5.03	5.38	4.96	5.42	5.24	4.99
Total Test Mean	43.06	50.03	43.84	34.12	37.97	37.79	38.52	43.63
S. D.	11.01	9.61	11.95	11.07	10.93	12.98	11.91	11.96

Differences Among Means

Common Items								
Conventional	----			----			----	
Study Guides	+2.13 ^a	----		+1.71	----		+1.83 ^b	----
Films Only	+ .19	-1.94	----	+ .67	-1.04	----	+ .41	-1.42
Total Test								
Conventional	----			----			----	
Study Guides	+6.97 ^c	----		+3.85	----		+5.10 ^b	----
Films Only	+ .78	-6.19 ^b	----	+3.67	-.18	----	+2.20	-2.91

NOTE: The sign of the difference is determined by subtracting the mean for the group at the side of the row.
 from the mean of the group at the side of the column
^a significant at the 10% level of confidence
^b significant at the 5% level of confidence
^c significant at the 2% level of confidence

GENERAL SCIENCE ACHIEVEMENT RETEST (CALVERT FORM B) MEANS, STANDARD
DEVIATIONS, MEAN DIFFERENCES, AND PRETEST-RETEST GAINS, BY SEX AND METHOD
Means and Standard Deviations

	B O Y S				G I R L S				COMBINED METHODS			
	Conven- tional	Study Guides	Films Only		Conven- tional	Study Guides	Films Only		Conven- tional	Study Guides	Films Only	
Number of Cases	32	29	31		34	34	33		66	63	64	
Calvert Living Things Retest												
Mean	30.31	33.28	30.00		26.74	28.65	27.91		28.47	30.78	28.92	
S. D.	4.13	4.88	7.00		4.69	5.39	5.59		4.77	5.65	6.40	
Mean Gain (retest- pretest)	+2.31 ^a	+1.60	+1.42		+2.98 ^b	+6.56 ^c	+1.43		+2.62 ^d	+4.12 ^d	+1.42	
Calvert Total Science												
Mean	69.78	74.76	66.74		59.97	63.85	63.67		64.73	68.87	65.16	
S. D.	9.73	8.91	16.73		9.33	12.37	14.36		10.71	12.19	15.63	
Mean Gain (retest- pretest)	+4.02	+5.44 ^a	+2.39		+6.85 ^b	+11.76 ^d	+5.37		+5.39 ^b	+8.84 ^d	+3.93	

Differences Among Retest Means

Calvert Living Things												
Conventional	-----				-----				-----			
Study Guides	+2.97 ^c	-----			+1.91	-----			+2.31 ^c	-----		
Films Only	-.31	-3.28 ^a	-----		+1.17	-.74	-----		+.45	-1.86	-----	
Calvert Total Science												
Conventional	-----				-----				-----			
Study Guides	+4.98 ^b	-----			+3.88	-----			+4.14 ^b	-----		
Films Only	-3.04	-8.02 ^b	-----		+3.70	-.18	-----		+.43	-3.71	-----	

NOTE: The sign of the difference is determined by subtracting the mean for the group at the top of the column from the mean of the group at the side of the row.

- a significant at the 10% level of confidence
- b significant at the 5% level of confidence
- c significant at the 2% level of confidence
- d significant at the 1% level of confidence

TABLE 12
DIFFERENCES AMONG MEAN GAINS ON CALVERT SCIENCE ACHIEVEMENT TEST,
BY SEX AND METHOD GROUP

METHOD	S E X	COMBINED SEXES								
		B O Y S			G I R L S			CONVEN- STUDY FILMS		
		Conven- tional	Study Guides	Films Only	Conven- tional	Study Guides	Films Only	Conven- tional	Study Guides	Films Only
Calvert Living Things										
	Conventional	----	----	----	----	----	----	----	----	----
	Study Guides	-.71	----	----	+3.58	----	----	+1.50	----	----
	Films Only	-.89	-.18	----	-1.55	-5.13 ^b	----	-1.20	-2.70	----
Calvert Total Science										
	Conventional	----	----	----	----	----	----	----	----	----
	Study Guides	+1.42	----	----	+4.91	----	----	+3.45	----	----
	Films Only	-1.63	-3.05	----	-1.48	-6.39	----	-1.46	-4.91	----

NOTE: The sign of the difference is determined by subtracting the mean gain for the group at the top of the column from the mean of the group at the side of the row.

^b significant at the 5% level of confidence.

On the retest, the Study Guides group scored consistently higher, both boys and girls, than either of the other two groups, and for boys these differences were significant of the 10 per cent level of confidence or better. For boys, the Conventional group mean for each test was higher than the Films Only group mean, while for girls the reverse was true.

It is to be noted that in no instance was the mean gain for the Films Only group significantly greater than zero at the 10 per cent level of confidence. The girls in the Study Guides method group scored a mean gain significant at the 2 per cent level (on "Living Things" subtest) and at the 1 per cent level (on the "Total Science" test). These were the only notable gains observed. However, all groups earned higher mean scores, indicating that probably something was learned that related to performance on the Calvert Test¹¹.

In Table 12 the differences among the mean gains are reported. It is to be noted that the Films Only group consistently gained less than either of the other two groups, and that, except for the boys on the Calvert "Living Things" sub-test, the Study Guides method group gained more than the Conventional method group. However, with one exception none of these differences was significantly greater than zero at the 10 per cent level of confidence or better. On the Calvert "Living Things" sub-test the mean score of the Films Plus Study Guides girls exceed that of the Conventional group girls. This difference was significant at the 5 per cent level.

Summary of Results

The results may be summarized as follows:

1. For three units, "Adaptations", "Classifications", and "Elementary Psychology", the Films Only group was consistently lower than either of the other two groups on the immediate recall test, both on all the items in the tests and on the items common to the three methods. The "Films Only" group was also lower than the other two groups on the science information retest, and gained less in science information than either of the other two groups. Very few of these differences, however, were statistically significant at the 10 per cent level of confidence or better. The Films Only group means were slightly higher than the Conventional group means for the unit test on "Elementary Electricity", and for the retention test after three months.

¹¹ The test of the significance of the gains did not take into account the correlation between the pre-test and the retest. Had this correlation been taken into account, the standard errors of the differences would have been reduced, and the related probability estimates would have been smaller. However, the gross differences were for the most part negligible and the interpretation presented here would not be changed.

2. The differences between the Conventional method and the Films Plus Study Guides method were generally inconsequential, and favored the latter group somewhat more frequently than they favored the former group.

In evaluating the observed differences in performance on immediate tests especially those involving the Films Only Group, two important considerations should be kept in mind. First, the initial inferiority of this group on the general intelligence tests may have slightly more than compensated for the superiority of this group on the science achievement test. Since all the final differences are slight, this sort of regression might reduce them to zero. Second, and more importantly, the Films Only group completed the course in an average of 37 class periods (Table 2) as compared with an average of 47 periods for the Conventional group and 46 1/2 periods for the Study Guides group. In short, the Films Only group required only 80% as long as either of the other two groups to learn only a negligibly smaller amount of information. Furthermore, the evidence suggests that, for long-term retention, the Films Only group is superior to the Conventional method group.

3. On the basis of pre-tests of general intelligence and knowledge of science, it was noted that the Films Only group was consistently lower than either of the other two groups in general intelligence, and that the girls in the Films Only group were slightly superior to the girls in the other two groups in general science knowledge. These differences in initial ability, however, were for the most part not greater than might have been expected by chance alone.

4. In all comparisons, the boys were superior to the girls included in the same method group. However, the order of effectiveness of the three methods was the same for the two sexes for almost every test. Thus, it is reasonable to conclude that there is no sex difference with respect to the effectiveness of the methods.

5. Finally, the Films Plus Study Guides group was consistently superior on the film retention test and on the Science Achievement retest, and in retest-over-pre-test gains.

IV. CONCLUSIONS

The over-all results of this study suggest that an informational content such as high school general science may be taught by films alone almost as effectively as by a teacher using the full repertoire of classroom techniques (except films); and by films introduced and supplemented by brief study guides perhaps a little more effectively than by conventional non-film teaching methods. It must be understood that the criterion of effectiveness adopted in this study has been solely measurement of learning of factual content. It may well be that teachers provide greater motivation and interest, encourage a wider range of out-of-class activities related to the class work, aid in the development of critical thinking ability via classroom discussions (which were totally lacking in the experimental film situation), and so forth. On these points the present study furnishes no information. The only long-range effect noted was a slightly greater retention of facts by the film groups. It is conceivable that one or more of the teachers inspired one or more students to make science their life goals, and that the films had no such inspirational impact. On the other hand it should be mentioned that the films used were not especially produced to cover the subject areas specifically and fully.

The foregoing considerations must be taken into account in evaluating the present study. It seems clear, however, that in a mass training situation, where the task is to impart a specific body of factual information that is to be recalled (used) at some future date, a course of films carefully produced to cover systematically this information should result in as effective learning as a training course led by instructors using traditional classroom methods. This general finding is of particular importance in situations where there is a shortage of skilled teachers or instructors or a shortage of equipment for use in training.

Limitations and Suggestions for Further Study

It is important that the findings of this study not be overgeneralized. The results stated herein concerned only the learning of facts and concepts. It did not consider any of the many other valuable types of learning that might be expected to result from good science instruction. The development of intellectual and manipulative skills, the awakening of interests, and the formation of scientific attitudes were not measured.

A mode of practical instruction was not considered; that is, the method of instruction in which the skillful teacher blends a variety of instructional materials giving prime importance now to the movie, again to the textbook, and yet again to some other teaching device.

The effect on learning of the mere presence, in a roomful of 40 pupils, of a person known to be a teacher has not been measured, nor has the effect of "group solidarity" or the "we feeling". How would the subjects behave in film groups of 400 instead of 40? How would their learning be different with no one but a non-teaching adult in charge? Would the lack of membership in a small group adversely affect learning in large audiences?

The foregoing limitations raise these and other questions which need to be answered by additional experimentation, the nature of which is plainly suggested by the questions and limitations themselves. If the implications of the findings of such experimentation were carried into practice, a certain set of answers could be the basis for a tremendous revolution in training and educational organization and procedures.

APPENDIX A

FILMS USED IN VARIOUS UNITS

Unit I. How are Plants and Animals Fitted to the Conditions Around Them? (Adaptation)

1. How Nature Protects Animals, EBF, 1939.
1 Reel, Sound, Monochrome.
2. Camouflage in Nature Through Pattern Matching. Coronet, 1946.
3/4 Reel, Sound, Color.
3. Camouflage in Nature Through Form and Color Matching. Coronet, 1946.
1 Reel, Sound, Color.
4. Mammals of the Rocky Mountains. Coronet, 1947.
1 Reel, Sound, Monochrome.
5. Mammals of the Western Plains. Coronet, 1947.
1 Reel, Sound, Monochrome.
6. Animals in Modern Life, EBF, 1937.
1 Reel, Sound, Monochrome.
7. Seed Dispersal. EBF, 1931.
1 Reel, Sound, Monochrome.
8. Flowers at Work. EBF, 1931.
1 Reel, Sound, Monochrome.
9. Control of Body Temperature. EBF, 1940.
1 Reel, Sound, Monochrome.
10. How Animals Defend Themselves. Young America, 1948.
1 Reel, Sound, Monochrome.
11. How Animals Eat. Young America, 1948.
1 Reel, Sound, Monochrome.

Unit II. How Do Scientists Classify Living Things? (Classification)

1. Animal Life. EBF, 1931.
1 Reel, Sound, Monochrome.
2. Life in a Drop of Water. Coronet, 1947.
1 Reel, Sound, Monochrome.
3. Beach and Sea Animals, EBF, 1931.
1 Reel, Sound, Monochrome.
4. Seashore Oddities. Young America, 1947.
2 Reels, Sound, Color.
5. Beneath Our Feet. Teaching Film Custodians
1 Reel, Sound, Monochrome.
6. Butterflies. EBF, 1931.
1 Reel, Sound, Monochrome.
7. The Sunfish. EBF, 1942.
1 Reel, Sound, Monochrome.
8. The Frog. EBF, 1931.
1 Reel, Sound, Monochrome.
9. Reptiles. EBF, 1932.
1 Reel, Silent, Monochrome.
10. Birds of Prey. EBF, 1931.
1 Reel, Sound, Monochrome.
11. Plant Life. Harvard University, 1931.
1 Reel, Sound, Monochrome.
12. Fungus Plants. EBF, 1931.
1 Reel, Sound, Monochrome.

Unit III. How Do Living Things Behave?
(Elementary Psychology)

1. The Nervous System. EBF, 1937.
1 Reel, Sound, Monochrome.

2. Cats in a Puzzle Box. Psychological Cinema Register, 1938.
1 1/4 Reels, Silent, Monochrome.
3. An experiment on the Color Sense of Insects. Psychological Cinema Register, 1943.
1/2 Reel, Silent, Color.
4. Reactions in Plants and Animals. EBF, 1931.
1 Reel, Sound, Monochrome.
5. It's the Brain that Counts. Women's Christian Temperance Union.
2 Reels, Sound, Monochrome.
6. Underground Farmers. Library Films.
1 Reel, Sound, Monochrome.
7. The Dodder. EBF, 1931.
1 Reel, Sound, Monochrome.
8. Killers of the Insect World. Teaching Film Custodians.
1 Reel, Sound, Monochrome.
9. Plant Traps. EBF, 1931.
1 Reel, Sound, Monochrome.

Unit IV. How do we Make and Use Electrical Current?
(Elementary Electricity)

1. Magnetism. Coronet, 1947.
1 Reel, Sound, Monochrome.
2. Introduction to Electricity, Coronet, 1948.
1 Reel, Sound, Monochrome.
3. Flow of Electricity. Young America, 1946.
1 Reel, Sound, Monochrome.
4. The Primary Cell. EBF, 1944.
1 Reel, Sound, Monochrome.
5. Water Power. EBF, 1937.
1 Reel, Sound, Monochrome.

6. Current and Electromotive Force. U. S. Navy, 1943 (Castle)
1 Reel, Sound, Monochrome.
7. Series and Parallel Circuits. EBF, 1944.
1 Reel, Sound, Monochrome.
8. Amperes,, Volts, and Ohms. U.S. Navy (Castle), 1943.
1 Reel, Sound, Monochrome.
9. Home Electrical Appliances. EBF, 1944.
1 Reel, Sound, Monochrome.
10. Development of Communications. EBF, 1942.
1 Reel, Sound, Monochrome.
11. Magic in the Air. General Motors, 1942.
1 Reel, Sound.
12. Induced Currents. EBF, 1930.
1 Reel, Silent, Monochrome.

APPENDIX B
SAMPLE STUDY GUIDES

DEFINITIONS

On this page we have defined some terms that you will find frequently on the study guides and in the films. Learn the meaning of these terms. Most of the terms explain techniques that are used in making motion pictures.

1. Animation, a motion picture technique whereby drawings, models, lines, arrows, etc. are made to appear to be in motion.
2. Demonstration, the explanation or illustration of how something works or how something is done, by the use of specimens, models, etc.
3. Slow motion, a technique employed in motion picture photography to reproduce on the screen motion that is slower than the original, to accomplish this, the film is exposed at a rate faster than normal and is projected at a normal rate.
4. Synopsis, a short general statement of the contents of a film.
5. Photomicrography, the science or process of making enlarged photographs of microscopic objects by means of a camera attached to a microscope.
6. Technique, the method or the details of procedure necessary to do something expertly.
7. Telephotography, the technique in photography by which distant subjects are made to appear closer through the use of long-focus lens.
8. Time-lapse photography, in motion pictures, the technique by means of which a slow process, such as the opening of a flower, or the growth of a plant, may be presented on the screen in a relatively short time, based on making a series of single frame exposures separated by a uniform lapse of time, which may vary from seconds to hours.

Name _____

Grade _____

Date _____

Film Study Guide No. _____

Unit 1: Adaptation of Plants and Animals

Film: Flowers at Work

Topic: An explanation of the reproductive function of the flowers of plants and what adaptations they have to insure fertilization.

Directions:

1. Read the synopsis to get a general idea of the content of the film.
2. Study the words in the vocabulary because these are words that will be used in the film.
3. Read the questions carefully before you see the film. Do not answer them until after you have seen the film.
4. After seeing the film write in the blank answer space after each sentence the word, group of words, or number that will complete the sentence or answer the question.

Synopsis:

How does a flower produce seeds? The structure of flowers and the function of each part of a flower, their pollination and fertilization and the devices employed by different flowers in accomplishing cross-pollination are explained very clearly. You will see how plants are dependent upon insects to a great extent for successful pollination.

Vocabulary:

1. Petal: One of the row of flower parts which surround the stamen.
2. Stamen: The part of a flower which bears the pollen.
3. Pistil: The central part of a flower, consisting of ovary, style and stigma.
4. Sepal: One of the outer row of flower parts, usually green.
5. Anther: The club-like tip of the stamen, in which pollen is formed.
6. Stigma: The tip of the pistil.
7. Reproduction: The process by which new living things are created.

8. Self-pollination: The process whereby the pollen of a flower fertilizes the ovules in the same flower.
9. Cross-pollination: The process whereby the pollen of one flower comes into contact with the stigma of another flower.

Questions:

1. What is the real purpose of a flower? 1. _____
2. What part of the flower contains the pollen? 2. _____
3. What are the four main parts of the flowers in regard to reproduction? 3. _____
4. How is pollen usually carried from flower to flower? 4. _____
5. How does the pollen reach the ovules of the pistil? 5. _____
6. In what part of the flower do the seeds develop? 6. _____
7. What attracts insects to flowers? 7. _____
8. How does the monkshood flower protect its pollen? 8. _____
9. What flower shoots its pollen out from the plant? 9. _____
10. What special device has the meadow sage for pollination? 10. _____
11. What happens to the flower after fertilization takes place? 11. _____
12. To what flowering family does the dandelion belong? 12. _____
13. The lupin flower forms its pollen in a _____. 13. _____
14. Name two flowers that are members of the composite family. 14. _____
15. How many anthers does the daisy have? 15. _____
16. How many tiny flowers in a dandelion head? 16. _____
17. The female reproductive part of the flower is the _____. 17. _____
18. What flower is shown as the film opens? 18. _____
19. What flower was developed for beauty but lacks reproductive organs? 19. _____

20. Draw a diagram of the main reproductive parts of a flower.

Name _____

Grade _____

Date _____

Film Study Guide No. _____

Unit: Electricity

Film: Amperes, Volts and Ohms

Topic: Amperes, Volts and Ohms

Directions:

1. Read the synopsis to get a general idea of the content of the film.
2. Study the words in the vocabulary because these are words that will be used in the film.
3. Read the questions carefully before you see the film. Do not answer them until after you have seen the film.
4. After seeing the film write in the blank answer space after each sentence the word, group of words, or number that will complete the sentence or answer the question.

Synopsis:

In electricity, as in other things, we wish to measure electric currents. For this purpose we use the unit, the volt, to measure electrical pressure; the unit, the ampere, to measure the quantity or flow of electricity; and the unit, the ohm, to measure resistance. The film discusses these units and the instruments with which we measure them.

Vocabulary:

1. Ampere: The unit for measuring the rate at which an electrical current flows through a wire.
2. Volt: The unit used in measuring electrical pressure.
3. Ohm: The unit for measuring resistance.
4. Ammeter: The instrument for measuring the rate of flow of current in amperes.

5. Völtmeter: An instrument for measuring the number of volts of
of an electric circuit.
6. Electromotive Force: E, M. F., voltage or electrical pressure
measured in volts.
7. Ohms Law: The current flowing in a circuit is equal to the electro-
motive force divided by the resistance.
8. Resistance: The opposition to the flow of electricity.
9. Coulomb: A unit for measuring electricity; the amount of electricity
conveyed by one ampere in a second.

Questions:

1. One Coulomb per second equals one _____. 1. _____
2. How many amperes did the hot plate use? 2. _____
3. What does the number of amperes indicate? 3. _____
4. What does the rate of flow depend on? 4. _____
5. What does a voltmeter measure? 5. _____
6. Does a voltmeter have high or low resistance? 6. _____
7. What is meant by the electromotive force of
a dry cell? 7. _____
8. What is the standard unit of resistance? 8. _____
9. Write Ohm's law in the three forms by which
you can calculate I, R and E, respectively. 9. _____
10. Would you place an ammeter in the circuit or
across the circuit? 10. _____
11. The pressure required to push one ampere
through one ohm is _____. 11. _____
12. What is the resistance, if the E. M. F.
is 120 and the amperage is 6? 12. _____

- | | |
|---|-----------|
| 13. What is a circuit? | 13. _____ |
| 14. What is the E. M. F. of two dry cells connected in series? | 14. _____ |
| 15. Does a small water pipe have <u>small</u> or <u>great</u> resistance? | 15. _____ |
| 16. What would happen if you placed an ammeter across the circuit? | 16. _____ |
| 17. What two kinds of units characterize the electric current? | 17. _____ |
| 18. In Ohm's law, what does I stand for? | 18. _____ |
| 19. What does E stand for? | 19. _____ |
| 20. Draw a sketch of the device for remembering Ohm's law. | 20. _____ |